SOUTHERN AFRICA: FOOD SECURITY POLICY OPTIONS

Correct citation:
Mandivamba Rukuni and Richard H. Bernsten, eds. 1988. *Southern Africa: Food Security Policy Options.* Proceedings of the Third Annual Conference on Food Security Research in Southern Africa. 1-5 November, 1987. University of Zimbabwe/Michigan State University Food Security Research Project, Department of Agricultural Economics and Extension, Harare.

Library of Congress # HD9017.567

SECTION 2: MARKET LIBERALISATION AND FOOD SECURITY

SECTION 3: HOUSEHOLD FOOD INSECURITY IN SORGHUM BASED FARMING SYSTEMS IN THE SADCC REGION

ACKNOWLEDGEMENTS

This proceedings of the Third Annual Conference on Food Security Research in Southern Africa is the product of close cooperation between social scientists, technical scientists, government officers, and donor agencies in Southern Africa. The studies reported in the proceedings are part of a comparative analysis of food security in Sub-Saharan Africa that is directed by Michael Weber of Michigan State University's Department of Agricultural Economics. The UZ/MSU food security research programme is being carried out through a sub-contract with Michigan State University.

In the Ministry of Lands, Agriculture, and Rural Resettlement, we acknowledge the generous support provided by Sam Muchena and John Dhliwayo who are responsible for the close collaboration between the food security research project and the SADCC Food Security Technical and Administrative Unit--responsible for developing and managing SADCC's Food Security Programme. They have been particularly helpful in identifying relevant research themes that complement the SADCC programme.

The research supporting the preparation the proceedings papers was financed by the U.S. Agency for International Development, Bureau of Science and Technology; Bureau for Africa; and the Southern Africa Regional Programme; under a *Food Security in Africa* cooperative agreement (DAN-1190-A-00-4092-00) with the Department of Agricultural Economics, Michigan State University and a sub-contract with the Department of Agricultural Economics and Extension, University of Zimbabwe. We are grateful to the following present and former USAID officials for their support to the project's efforts to strengthen indigenous research capacity for food security policy research: Don Anderson, Curt Reintsma, Thomas Mehen, Calvin Martin, David Atwood, Ernesto Lucas, Michael Yates, Roy Stacy, Dale Pfeiffer, Pamela Hussey, and Janet Schulman. We are particularly appreciative of the support provided by Allison Herrick, Eric Witt and Joshua Mushauri of the Southern Africa Regional Programme, Harare.

We convey special thanks to Thembi Sibanda for an excellent job in organizing the Third Annual Conference, and to the many individuals who helped to make the conference a success: Murie Hutchison, Lovemore Nyabako, Maxwell Chiwashira, Samson Maguhudze, George Nyamatemba, Ronald Sagwete, Pete Hopkins, and Andrew Barnes.

We are especially indebted to Mrs. Corinne Smith for her patience, skill, and dedication in word processing the numerous drafts of the chapters included in this proceedings. Her persistence in mastering the word processing and laser printer technology has been exceptional.

Finally, we thank Chris Wolf and Elizabeth Bartilson for providing technical support for the laser printing technology used to print the proceedings.

THE STATE OF THE ART OF SORGHUM RESEARCH FOR COMMUNAL FARMERS IN ZIMBABWE

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INTRODUCTION

Sorghum *(Sorghum bicolor (L) Moench)* is a traditional food crop in Zimbabwe. It is generally grown in low-rainfall areas, particularly in Natural Regions III-V (Vincent and Thomas, 1960) which includes nearly 75% of the communal areas (Mugabe and Taguta, 1985).

These areas have great genetic diversity. Phenotypic variability is greatest in the southeast in Natural Regions IV and V. Matabeleland has the greatest diversity of landraces (Mushonga and Appa Rao, 1987) which probably explains why more sorghum is grown in Matabeleland communal areas than elsewhere. However, previous research has shown that the most profitable yields are obtained on heavy soils (Cackett, 1960). Sorghum yield data, compiled by the Central Statistics Office (1985) for the past five years, showed an average yield of 0.34 mt/ha for peasant farmers, compared to 2.10 mt/ha for commercial farmers. The yield difference could be due to poorer soil, lower quality seed, or different cultural practices used by peasant farmers.

GERMPLASM COLLECTION AND EVALUATION

Collection

During the 1900s most sorghum germplasm used in the breeding programme was of foreign origin. This included materials from East Africa--particularly Uganda and a combination of Kenyan and Tanzanian genotypes. Some germplasm also came from Nigeria, South Africa, and the United States. Breeders have used these materials for some time to produce various genotypes suitable for both animal feed and opaque beer. These exotic genotypes were mostly brown and unsuitable for processing into human food. However, the realisation that local germplasm was eroding--due to the introduction of improved varieties and hybrids--resulted in an effort to build a strong genetic base. During April to August 1982, the International Board for Plant

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Genetic Resources (IBPGR), the Crop Breeding Institute (CBI) of the Department of Research and Specialist Services (DR&SS) and the International Crop Research Institute for Semi-Arid Tropics (ICRISAT) launched a germplasm collecting mission for major Zimbabwe crops, including sorghum (Appa Rao and Mengesha, 1982; Toll and Gwarazimba, 1983). A second collection mission was launched during 1985 in which 733 sorghum samples were collected from farmers' fields, 414 samples from the International Trade Fair[2], Bulawayo, and 319 samples from the Harare Agricultural Show[2] (Appa Rao *et al.*, 1986). Plant collectors made several trips to different parts of the country when the crop was adequately mature. The collected samples were numbered with the prefix TGR and AMM, indicating the abbreviations of the collectors' names from the two missions.

Sorghum races and intermediates

The collection exercise identifited five basic races (Kafir, Caudatums, Guinea Dura, and Bicolor) and several intermediates (mostly of Kafir, Caudatum and Guinea). The occurrence of all five basic races in Zimbabwe is probably due to its geographical location between Southern Africa and Western Africa, diverse agroclimatic conditions, and farmers' selection, as well as maintenance of different race types. A variety of agroclimatic conditions (Kay, 1986), differences in altitude, temperature, rainfall, and soil conditions are also responsible for the occurrence of all five races. The distribution of these races are as follows:

- o Kafir. This race originated in Southern Africa, which includes Zimbabwe (de Wet and Harlon, 1976). It is extensively distributed throughout the country, but genetic variability was more abundant in the south of the country in Regions IV and V.
- o Caudatums. This race is largely grown in Masvingo province, Matabeleland South, and Manicaland Provinces.
- o Guinea. Although this race originated in West Africa, it has secondary centres in Tanzania and Malawi. It is commonly grown in southern Zimbabwe.
- o Durra. The origin of this race is Ethiopia. However, some traces have been found in Zimbabwe germplasm.
- o Bicolor. This race has no particular area of concentration and is found throughout Zimbabwe. The sweet sorghums in the area come from this race.

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[2]Samples were taken from grain farmers brought in to display at the fair/show.

The most common intermediates are hybrids between Kafir, Caudatum, and Guinea. Farmers have played a major role creating these through growing different races adjacent to each other or mixtures of races.

The greatest diversity of landraces and their intermediates was observed in Matabeleland Province, but deceases as one moves to the north towards the Zambezi Valley (Mushonga and Appa Rao, 1987).

Evaluation

Sorghum was evaluated at the Variety Testing Centre (VTC) Gwebi, Panmure Experiment Station, and at Matopos Research Station; in collaboration with the SADCC/ICRISAT sorghum and millet improvement programme. To assess the full potential of the material, the germplasm was grown under good management conditions.

The genotypes were evaluated to determine the number of days from emergence to flower and physiological maturity. This is necessary to separate the early, intermediate and late-maturing types. Also the endosperm was characterised in terms of hardness (soft or hard) and by grain shape. Yield data were also collected to assess if some of the genotypes were useful for including in a crossing programme.

BREEDING PROGRAM

Objective

In the past, the main emphasis in the sorghum breeding programme was on developing of high-yielding genotypes. However, quality parameters and agronomic traits have recently generated tremendous interest in the programme. To develop elite materials suitable for these traits, breeders have initiated an elaborate programme using the pedigree breeding method, following the head-to-row approach. The objective in this case has been to develop populations which will eventually lead to hybridisation.

Population generations

The programme has generated a wide range of breeding materials by exploiting the diverse material from the germplasm collected during 1982 and 1985, respectively. Exotic germplasm was also utilised in this exercise through hand-emasculation and using the plastic method. This approach has produced over 300 segregating populations of differing generations. The populations are being selfed and advanced through generations to develop elite lines suitable for varieties and hybrid parents.

The programme is giving priority to selecting for white corneous endosperm grain which is suitable for diversified food products. In addition to

white coloured grain, red and brown grain types are also being sought to meet other needs such as animal feed and malting for opaque beer.

Hybridisation

The planting of sorghum hybrids is on the increase in Zimbabwe. Both large- and small-scale commercial farmers are accustomed to growing hybrid sorghum. However, only a limited number of communal farmers grow hybrid sorghum due to the high cost of seed. Therefore, communal farmers more commonly grow open-pollinated varieties since the seed can be used for more than one season, a practice which cannot be followed with hybrid sorghum.

The elite lines which originated from germplasm collected have been very useful, both in the development of hybrids as well as a source of varieties that provides farmers with a wider choice of materials (Mushonga, 1983).

TESTING PROGRAMME

The testing programme has followed two stages, first on-station and then on-farm evaluation.

On-station testing

A number of hybrids and open-pollinated varieties have been tested on several research stations throughout the country. The experimental hybrids have out yielded the two commercial hybrids, DC 75 and DC 99. Two newly released open-pollinated white varieties (SV-1 and SV-2) were compared with these hybrids in preliminary variety trials at Gwebi and Kadoma Research stations in the 1982-83 season; and also assessed in intermediate variety trials at several research stations during the 1983-84 growing period. SV-1 and SV-2 performed well in both preliminary and intermediate trials. Further testing in advanced trial was conducted during the 1984-85 and 1985-86 seasons.

Averaged across all sites and years, DC 75 gave the highest yield (4.6 mt/ha), followed by DC 99 (4.1 mt/ha), SV-2 (3.3 mt/ha) and SV-1 (3.2 mt/ha) as shown in Table 1. Both DC 99 and DC 75 did well on most of the stations, except in 1985-86 at Panmure where both hybrids performed just under and slightly above 1 mt/ha, respectively. During the same season, the new varieties SV-1 and SV-2 averaged approximately double the yield of the hybrids. Yet overall, the hybrids outyielded the two varieties. DC 75 gave a 45% higher yield than SV-1 and a 41% higher yield than SV-2. This is to be expected due to hybrid vigour. Also, since management is better on research stations, both hybrids and varieties should perform better in on-station than in on-farm tests.

Table 1. Grain yield in advanced sorghum variety trial (mt/ha), 1984-85 to 1985-87, Zimbabwe.

		Variety				
Year	Site	DC75[a]	DC99[a]	SV-1[b]	SV-2[b]	C V [c]
1984-85	Gwebi	6.90	6.90	4.80	4.30	13.83
	Kadoma	5.50	4.90	4.70	4.60	13.03
	Panmure	6.90	7.80	6.90	6.10	10.95
	Matopos	5.20	4.50	2.70	4.30	37.16
	Rattray Arnold	2.10	2.20	2.20	2.30	11.91
	Makoholi	2.50	2.90	1.40	2.30	51.38
1985-86	Gwebi	7.28	6.70	2.54	3.12	12.70
	Kadoma	7.86	5.52	4.90	4.84	14.80
	Panmure	1.22	0.91	2.18	1.72	58.00
	Matopos	1.24	5.29	0.56	0.60	62.00
Variety Mean		4.62	4.09	3.16	3.28	

[a]Commercial hybrids;
[b]White open-pollinated varieties;
[c]Coefficient of variation (%)
Source: Plant Breeding Institute, DR&SS

On-farm testing

On-farm testing procedures were slightly different than thosed used on the research stations. The varieties compared were Red Swazi A, a widely grown open-pollinated variety, and the two new varieties, SV-1 and SV-2. The three varieties were evaluated during three consecutive seasons at several locations in Natural Regions II to IV. Unfortunately, trials at several sites were lost due to severe drought and poor seed establishment.

The recently released varieties, SV-1 and SV-2, slightly out-yielded Red Swazi A (Table 2). Also, their grain quality and plant type make them more desirable than Red Swazi A which has brown grain with a soft endosperm.

Important agronomic characteristics of sorghum include plant height, exertion, and seed size (Table 3). Plant height is an important varietal characteristic since the taller the crop, the more difficult it is to scare birds. Both SV-1 and SV-2 compare well to Red Swazi A in this respect. The exertion of both new varieties is within an acceptable range (Table 3).

The major advantages of SV-1 and SV-2 over Red Swazi A are white grain type, a hard endosperm, and the plant type. These grain characteristics contribute to high quality human food products.

GRAIN QUALITY EVALUATION

During the past several years, the sorghum improvement programme has concentrated on developing of red and brown grain types. The brown colour possesses a subcoat which contains tannins. Generally, these grains also contain soft endosperm which make them difficult to process. Most of the people in the rural area who use sorghum as a staple food depend on the traditional processing method, hand-pounding. However, a disadvantage of the traditional method is that it results in high grain loss through breaking --especially when using varieties like Red Swazi A, DC 99, and DC 75, due to their soft endosperm. Even if a mechanical dehuller is used, the grain recovery rate is lower than that obtained when dehulling hard endosperm, white grain types like SV-1 and SV-2.

To demonstrate the differences in dehulling quality between soft brown endosperm types and hard white endosperm grain; a small domestic-sized dehuller was developed. The dehuller was also intended to reduce the drudgery for women in dehulling sorghum grain, and thus encourage greater grain utilisation (Mushonga and Appa Rao, 1985). The dehuller consists of fine carborundum discs mounted on an axis connected to an electric motor. Dehulling is achieved by the abrasive action of the discs. Several brown and white were dehulled for 2-30 minutes. The results indicated a higher grain recovery rate for hard white endosperm varieties, compared to the soft

Table 2. Grain yield in communal areas (mt/ha) sorghum variety trial, 1984-85, Zimbabwe.

Year	Site	Variety			
		SV-1[a]	R.S.A[b]	SV-2[a]	C V [c]
1984-85	Wedza-Gunda	2.55	2.01	2.33	23.47
	Wedza-Manyadza	1.30	1.60	1.60	23.38
	Wedza-Magaba	3.10	2.00	2.50	26.74
	Mudzi-Kadyaukonde	1.20	1.30	2.00	46.13
	Suswe	4.00	2.40	4.40	25.49
	Mukumbura	2.80	2.60	1.50	40.30
	Rushinga-Machacha	3.50	2.60	3.60	22.19
	Matabeleland South	1.80	2.40	1.10	24.09
	Chilimanzi	2.10	1.90	1.60	35.05
1985-86	Wedza	1.08	1.28	0.92	38.00
	Wedza	2.40	2.27	2.25	27.80
	Mutoko	1.53	1.50	1.86	30.00
	Rushinga	1.21	0.72	1.27	28.15
	Wata	3.54	2.52	2.66	19.30
	Muzarabani	1.05	2.72	2.32	29.00
1986-87	Wedza	0.56	1.72	1.56	39.50
	Charter	0.67	0.89	1.00	39.70
	Mutoko	0.95	0.67	0.33	29.10
	Variety Mean	1.66	1.63	1.71	

[a]White open pollinated variety
[b]Red open-pollinated variety
[c]Coefficient of variation (%)
Source: Plant Breeding Institute, R&SS

Table 3. Plant characters over all communal trial area sites, 1984-85 to 1986-87, Zimbabwe.

Character[a]	No. of trials	Variety SV-1	SV-2	RedSwazi A
Plant height (cm)	15	125.00	145.00	119.00
Exertion (cm)	15	5.33	12.54	9.05
1,000 seed wt (g)	15	18.57	20.41	20.44

[a]Mean overall sites.
Source: Plant Breeding Institute, R&SS.

brown types at the end of 30 minutes. This indicates that hard white endosperm grain has superior grain quality, compared to soft brown endosperm types.

A palatability test was also conducted on white and brown flour. Both white and brown sorghum flour was made into thick porridge and a taste panel evaluated it. The majority of the panelists preferred the porridge from the hard white endosperm grain to the porridge from the soft brown grain.

DISEASE AND PEST EVALUATION

Diseases

Several leaf and grain diseases have been identified and evaluated in most of the research stations and on-farm trials. For several varieties, leaf blight and ergot ranked 3 and 4 on a scale of 1 to 5 with a greater number denoting higher severity. Other diseases identified were sooty stripe, grey leaf spot, zonate leaf spot, anthracnose, and rust. Cooperation between pathologists and breeders has been launched to assess if these are of economic importance. Research has shown that Red Swazi A suffers much more from leaf blight and ergot than SV-1 and SV-2.

Pests

The pests of economic importance are stalkborer, aphids and the American bollworm (Mushonga, 1982). Interestingly, aphid infestation is more common on both reasearch stations and commercial farms than in communal areas. Stalkborer is a serious sorghum pest. Research is under way to establish the level of susceptibility among varieties.

CONCLUSION

The sorghum research programme for the communal areas is concerned with developing high-yielding open pollinated varieties with good grain quality. We are also interested in developing elite lines from germplasm which is agronomically suitable for the communal farmer, with good disease and pest tolerance. There is also a need to develop early-maturing varieties, suitable for different regions, so that farmers will have a wide range of materials from which to choose.

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